Comparison of a Recurrent Neural Network PV System Model with a Traditional Component-Based PV System Model

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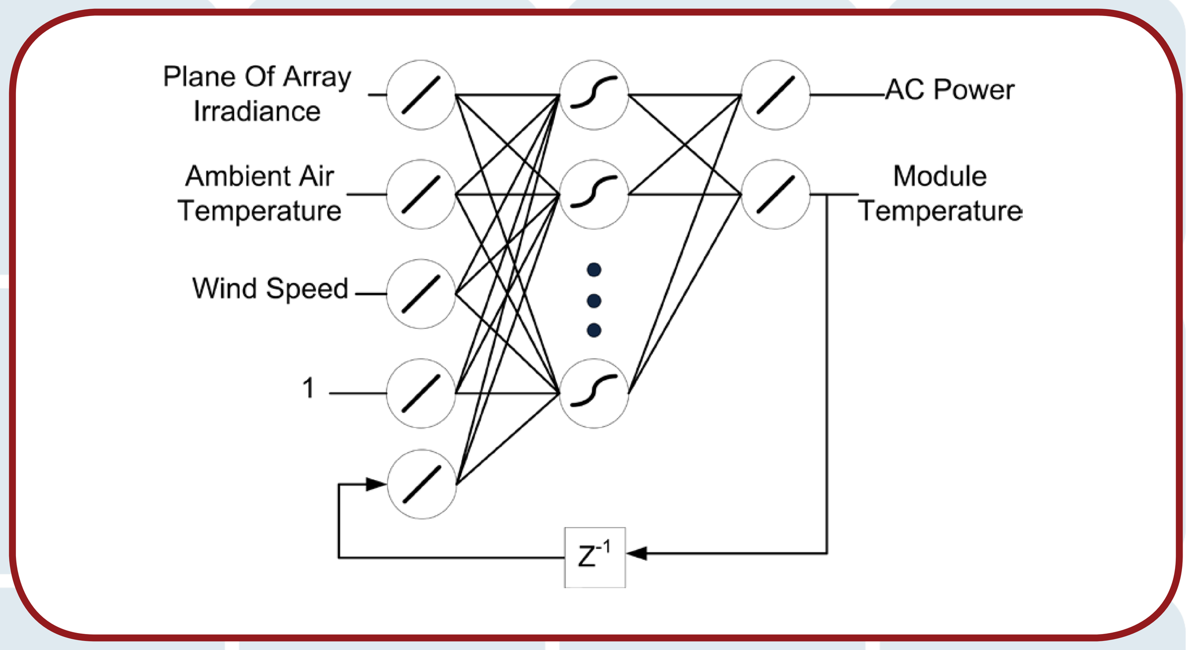
Abstract

Traditional PV system modeling approaches require system components to be tested in order to determine performance parameters. In some cases, system owners may wish to predict system performance, but lack the parameters necessary for typical modeling techniques. In these cases, it is possible to train a recurrent neural network to characterize an existing PV system and predict performance under a given set of weather conditions. Such a characterization may be useful in cases where component models are not available, the modeler does not know the specific components in the PV system, or where system components are installed or altered in such a fashion that the model parameters are no longer applicable.



Procedure

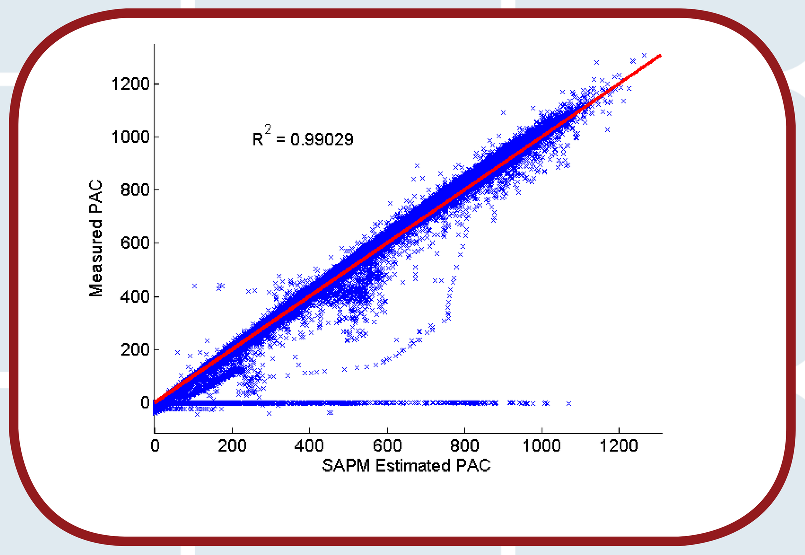
The recurrent neural network (RNN) trained to characterize and simulate a 1.05 kWp PV system using approximately 41 days of data. Data input fields consisted of a plane of array reference cell, ambient air temperature, and wind speed. A particle swarm optimization trained the RNN to predict AC power and module temperature. After training, the network was tested against over a year of data (including the training set). Modeled performance from the RNN were compared to measured performance data.

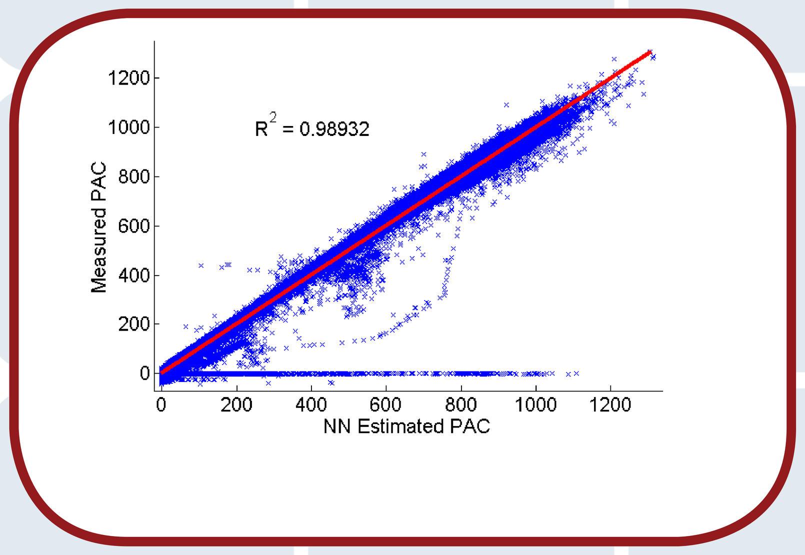
The Sandia Photovoltaic Array Performance Model (SAPM) and Grid Connected Photovoltaic Inverter model were similarly tested against the same 1 year of weather data. The performance of each method was compared as a whole and residual analysis was performed against the input parameters.

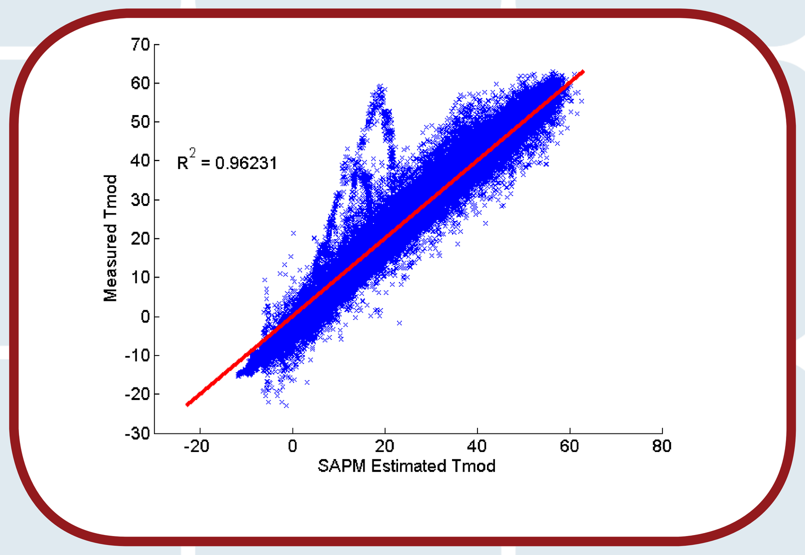
Results

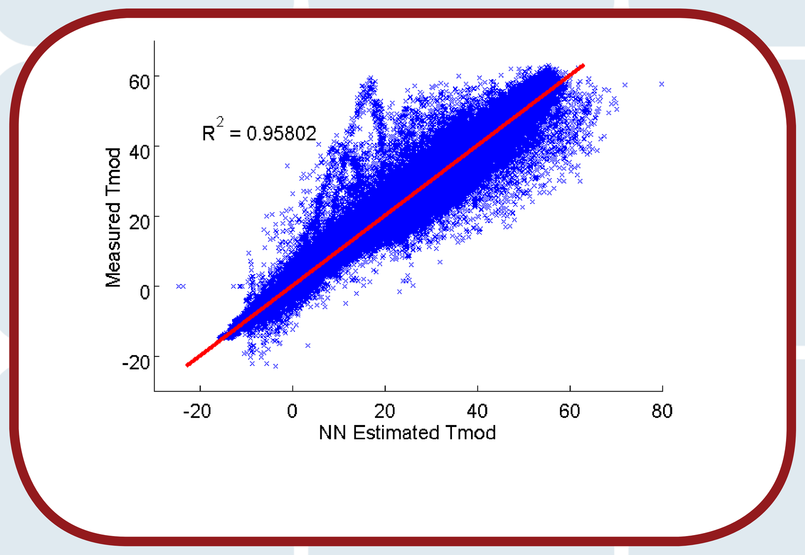
In general, the RNN-based model performed well, although not as well as the traditional component-based model (SAPM).

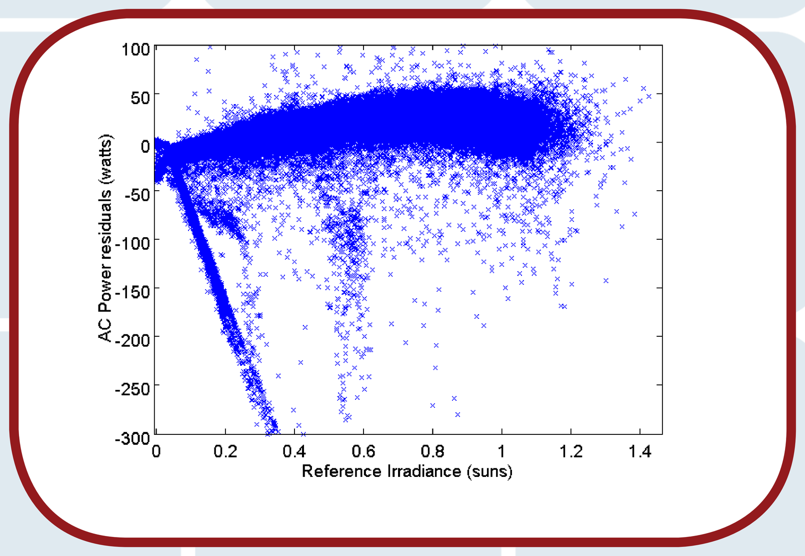
Sandia Component Models | **Recurrent Neural Network**

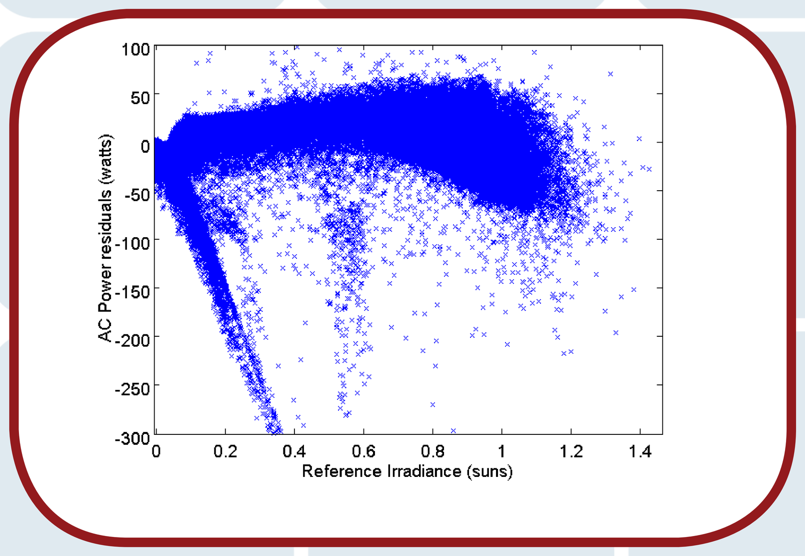


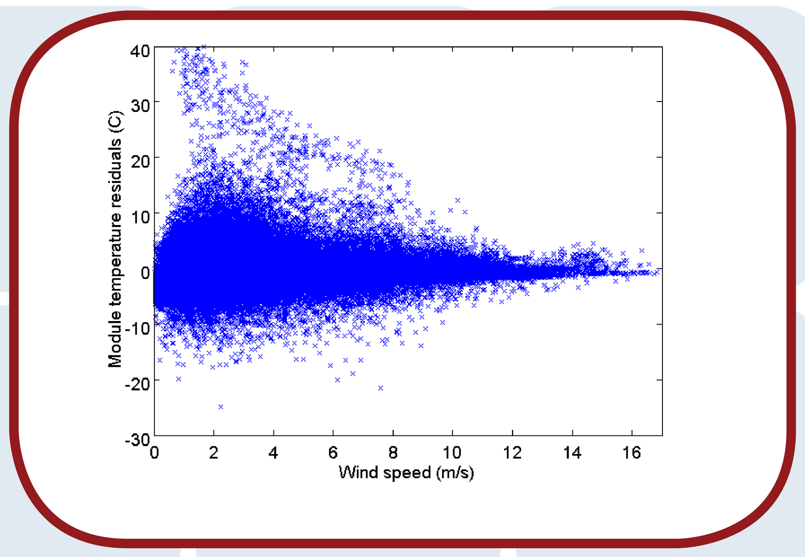


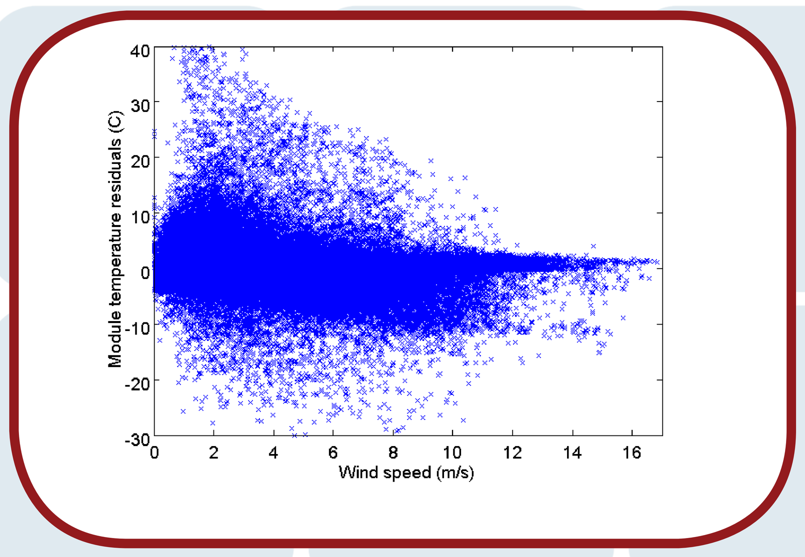










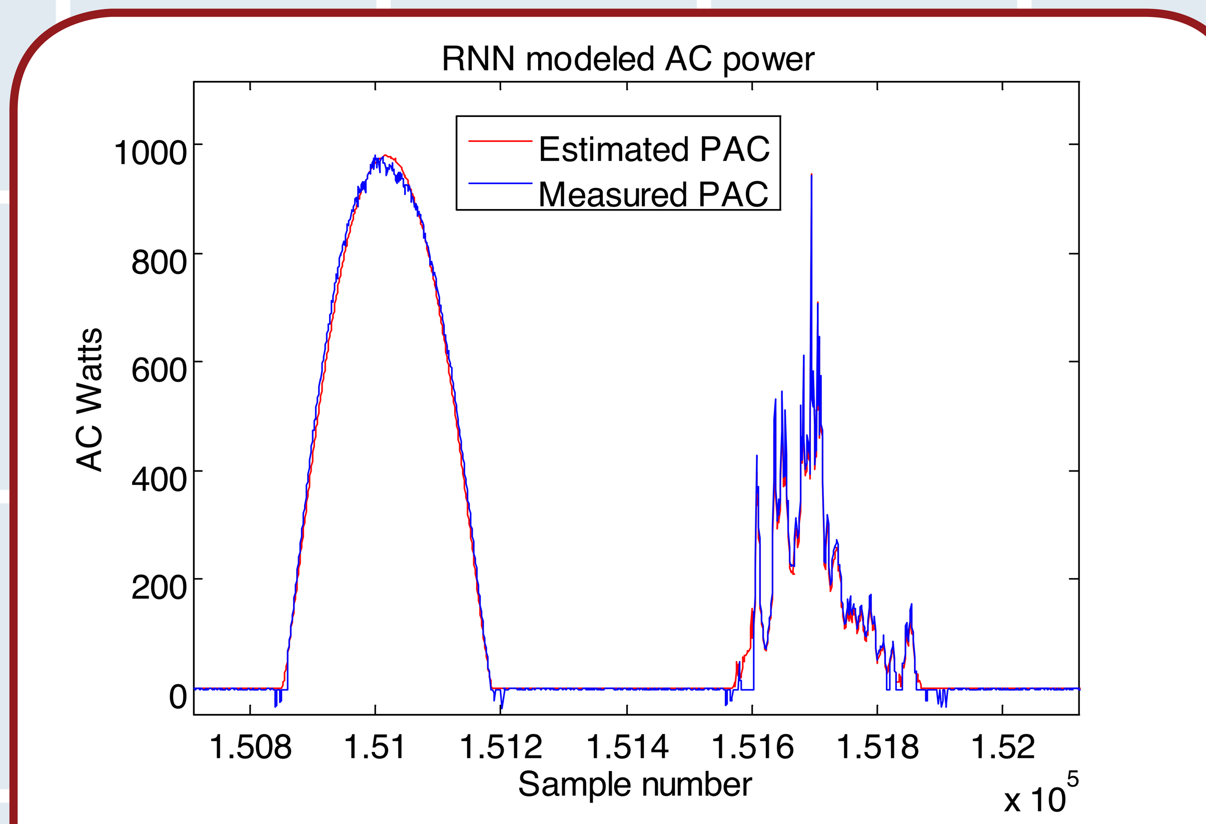


Model	RMSE	MAE	MBE
SAPM	3.06	2.35	1.04
RNN	3.23	1.88	-0.43

Module temperature performance, in °C

Model	RMSE	MAE	MBE
SAPM	3.05	1.05	-0.07
RNN	3.20	1.18	0.32

AC power model performance, as a % of rated power



Performance of the RNN on both a clear and cloudy day

Conclusion

A recurrent neural network may provide adequate modeling capabilities for circumstances which do not allow for a traditional component-based modeling approach.

A recurrent neural network approach does not require any knowledge of the system. Thus removing the need for component performance testing.

The recurrent neural network may only be used on systems which are already installed and monitored for desired data fields as concurrent weather and performance data are required to train the network.

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